ON THE CHARACTER OF THE ZEROS OF POLYNOMIALS RELEVANT TO THE SMALL CURVATURE APPROXIMATION IN ASYMPTOTIC DIFFRACTION THEORY

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In dealing with the problem of estimating the high frequency coupling between two antennas mounted on a non-metallic aircraft skin, one is faced with approximation of the spectral integrals representing the propagation of rays along the geodesics of the surface between the antennas. When the antennas are sufficiently separated, the integrals can be conveniently represented as a rapidly convergent residue series. On the other hand, when the antennas are in close proximity, the residue series fails to converge rapidly and a power series representation proves to be efficacious. [Paknys and Wang, IEEE Trans. AP-35(3), 1987, 293-298] When the effective surface impedance is not small, an intermediate region of separation appears in which neither the residue series nor the power series is effective. Recently, an asymptotic formalism was presented [Pogorzelski, National Radio Science Meeting, Boulder, CO, January 1995] which extends the earlier work of Bremmer [IRE Trans. AP-6, 1958, 267-272] and Wait [J. of Res. of NBS, 56(4), 1956, 237-244] describing a "small curvature approximation" to the case of general (non-azimuthal) ray directions on the surface of a cylinder (excluding only axial propagation). Based on the formulation of Pearson [Radio Sci. 21(4), 1986] this asymptotic formalism provided a means of approximating the spectral integrals in the intermediate region of separation.

In applying the above generalized small curvature approximation technique, one is faced with obtaining the zeros of high degree polynomials. This arises from the necessity of obtaining a partial fraction expansion of the approximated integrands. Ordinarily, this would be a computationally limiting factor in the efficiency of the overall technique. However, due to the somewhat convenient character of these polynomials, the zeros may be easily estimated analytically. These estimates are sufficiently close to the true zeros that numerical iteration based on Newton's method produces the desired zeros very accurately in very little computation time. Having analytical estimates of the zeros also provides insight into the effect of increasing the number of terms retained in the approximations used in the integrands. The estimation of the zeros and the implications of their locations are discussed in detail and example computations are described.